CHAPTER III : DEVELOPMENT OF INDIGENOUS CAPABILITY

Objective: To assess whether Indigenous capability was developed through LCA programme

3.1 Absence of Indigenisation Plan

The GoI sanction of LCA project (August 1983) envisaged use of as many sub-systems as were readily available in the world market. However, GoI sanction (June 1993) for FSED Phase-I required to shift the focus on maximising the indigenous development, even if it meant increase in cost and time, partly because of severe foreign exchange crunch faced by the country in early 1990s and partly for attaining self-reliance in critical areas. Accordingly, ADA had proposed (June 1993) to undertake indigenous development of items such as Jet Fuel Starter, Gear Box, avionics software development and mechanical systems of LCA. In addition, import content was planned to be reduced in design and development of Carbon Fibre Composite (CFC) Wing, Multi-Mode Radar, General systems, import of components instead of systems, apart from increase of import content in infrastructure and aircraft manufacturing activities.

In response to audit observation (July 2014) regarding indigenisation plan for LCA, ADA stated (August 2014/January 2015) that no indigenization plan/ roadmap for LCA was made because the scope of the Project was to develop advanced technologies/components along with LCA development. ADA, however, further stated (January 2015) that sufficient emphasis had been given towards indigenous design and development of various critical systems right from the beginning of the programme.

Various systems/equipment/items of LCA that were taken up for indigenous development are indicated in **Annexure II**. In response to an Audit query (July 2014) regarding the extent of indigenisation in LCA, ADA claimed (August 2014) that indigenous capability developed worked out to 70 *per cent* of the LCA content in terms of value.

Audit observed (August 2014) from the CCS Note submitted (August 2009) for extension of FSED Phase-II that indigenous Line Replaceable Units[1] (LRUs) had been developed with the imported electronic components and accessories.

In response to audit query (August 2014) on the extent of indigenous content, ADA clarified (October 2014) that the LRUs were built in-house using imported components with indigenous design qualifications and certification efforts and hence indigenous content had been worked out at LRU level. ADA, however, further stated that the indigenous content of LCA worked out to about 35 *per cent* considering the use of imported components and accessories in LRUs. ADA also confirmed (October 2014) the continued dependency on imported electronic components, accessories etc. for LCA.

In the absence of a roadmap for indigenous development, the efficiency and effectiveness of the indigenous development achieved in the LCA programme could not be assessed in Audit. We also observed (December 2014) that ADA had further initiated (February 2014) a proposal for indigenous development of 109 LRUs at an estimated cost of ₹479 crore.

3.1.1 Indigenisation efforts

While ADA successfully developed systems such as CFC Wing, Gear Box, efforts made by ADA and its work centres for indigenous development of major items like Kaveri engine, Radome, Multi-Mode Radar, Jet Fuel Starter, etc, were not completely successful as discussed below:

i. Development of Engine for LCA

GTRE's failure to develop Kaveri engine as per the requirements has made the LCA perennially dependant on imported aero engines throughout its service life

Government of India sanctioned (March 1989) a project for the design and development by Gas Turbine Research Establishment (GTRE) of an engine (named 'Kaveri') for LCA at a cost of ₹382.81 crore (FE ₹155.39 crore) with a PDC upto December 1996. The prototype version of LCA would be developed with a proven imported engine, while the production version of LCA was to use indigenous engine.

[1] It is a modular component of an aircraft that is designed to be replaced quickly in case of failure, which reduces down time of the aircraft.

GTRE, however, could not develop the Kaveri engine as per the LCA schedule and specifications; particularly the engine weight exceeded by 135 Kgs (1235 Kgs as against 1100 Kgs) and also engine thrust achieved was 70 kilo Newton (kN) against the requirement of 81 kN despite extensions of the project schedule till December 2009 and enhancement of the sanctioned cost to ₹2,839 crore (FE ₹1,730 crore). Inordinate delay in fructification of Kaveri engine and cost overrun of the programme was commented upon in Paragraph 5.1 of the Report No 16 of 2010-11 of the C&AG of India, Union Government, Defence Services (Air Force and Navy) for the year ended March 2009.

The Ministry in their Action Taken Note (ATN) had stated (August 2011) that indigenous development of Kaveri engine for technology demonstration would continue.

In response to the present position of the Kaveri Project sought for (December 2014) in Audit, GTRE stated (December 2014) that a revised proposal was under preparation to develop the Kaveri engine for another aircraft[2] at an estimated cost of ₹2652 crore and time frame of 7 years.

Thus, even after incurring (January 2015) a development expenditure of ₹2020 crore by GTRE, indigenous development capability for LCA propulsion was not successful and ADA would continue to depend on GE imported engine for LCA.

ii. Development of Radome

Radome developed by ASL and manufactured by HAL was not found suitable for LCA and imported Radome is yet to be tested along with MMR for assessing its performance

The Radome is a primary structure on an aircraft, which houses the antenna. It needed to possess electro-magnetic (EM) transparency to get the best performance of the Antenna as well as structural integrity. The Radome designed and developed by the Advance Systems Laboratory (ASL), Hyderabad was selected (December 1989) for the LCA prototypes.

[2] Unmanned Combat Air Vehicle (UCAV), being proposed for development by ADA.

Manufacturing of Radomes was started (June 2008) in HAL and the Regional Centre for Military Airworthiness (Aircraft), Bangalore accorded structural clearance (October 2009) to Radome manufactured by HAL. The first Electromagnetic test result of production Radome, supplied (December 2011) by HAL showed (June 2012) high loss of signal power resulting in significant reduction in radar range thereby affecting its performance. The Empowered Committee (June 2013) noticed that the losses of signal power were due to design deficiency and choice of Kevlar[3] material. Subsequently, due to this deficiency, ADA had to conclude (September 2013) a contract with M/s Cobham, England for development and supply of six Radomes[4] with quartz material at a cost of GBP 2.5 million (₹22.75 crore) by January 2015 for testing on LCA.

Thus, ADA has to depend on imported source for meeting the requirement of Radome as the one developed indigenously by ASL, Hyderabad and manufactured by HAL was not found suitable for LCA. This had impacted testing of MMR with cascading effect on accomplishment of FOC.

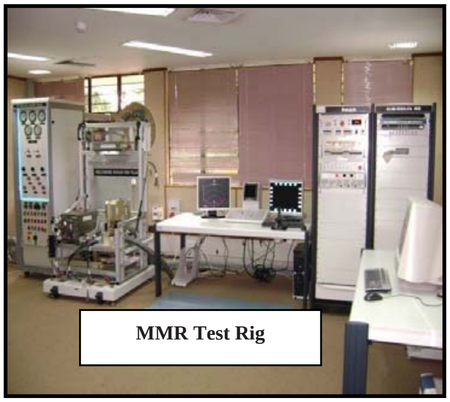
iii. Development of Multi-Mode Radar (MMR)

MMR developed jointly by LRDE/HAL had performance shortfalls and ADA had to go in for co-development of MMR with foreign firm, performance of which is yet to be tested with imported Radome

Multi-Mode Radar (MMR) is used in LCA for tracking targets from Air to Air, Air to Surface including sea. It facilitates all weather launching of weapons. It should operate under different modes viz., single target tracking (STT)[5] mode, close combat mode and air-to-ground ranging modes.

Multi Mode Radar (MMR)

3 Kevlar is a super-strong plastic.
4 One for qualification testing and the others for testing on different aircraft for consistency in results.
5 This mode is used to provide the most accurate information to the fire control computer so that accurate missile or gun firing can be accomplished.



The joint indigenous development of MMR for LCA was entrusted (June 1991) to M/s HAL,[6] Hyderabad Division and LRDE[7], Bangalore at a cost of ₹62.27 crore (FE ₹35.374 crore), to be completed by December 1997.

The delay in development of MMR despite consultancy from Ericsson and consequent import of three antenna were commented in Paragraph No 28 of Report of C&AG of India for the year ended March 1998 (No 8 of 1999).

However, Ministry's reply was silent on this aspect while furnishing (July 2004) the ATN.

The MMR developed by HAL/LRDE was found (2006) short of expectations. Subsequently ADA concluded (October 2006) a contract with M/s Elta Israel for co- development/ consultancy, supply & integration of MMR on LCA at a cost of 26.5 Million USD (₹119.25 crore) by June 2009. Though the MMR was ready by 2009 for integration on LCA, the LCA (LSP3) required structural changes in front fuselage for installation of MMR LRUs. After the LSP3 was ready in 2010, the MMR was put to functionality and performance testing. While the functionality testing of MMR was completed in December 2013, it could not be cleared in performance testing.

To an audit observation (October 2014) seeking reasons for delay in testing of MMR and resultant impact on IOC/FOC schedule of LCA, ADA stated (October 2014) that the MMR required several software updates during its development, which contributed to delay apart from non-availability of aircraft for testing. As regards availability of MMR for IOC achieved in December 2013, ADA stated (October 2014) that though MMR was integrated on LCA at the time of IOC, certain performance requirements such as range performance was falling short due to Radio Frequency (RF) losses of Radome and these limitations were recorded as part of Release to Service Document (RSD) of IOC of LCA. This had resulted in ADA concluding a fresh contract with M/s Cobham for an improved Radome with quartz material as has been discussed in sub-para 3.1 (ii).

6 Hindustan Aeronautics Limited.
7 Electronics and Radar development establishment.

As MMR performance could not be proven due to change in Radome, ADA had to obtain (December 2013) concession from Air HQ while obtaining IOC for LCA. As discussed in Para 2.3, Air HQ while commenting (December 2014) on impact of concessions on the combat potential of LCA, had stated with regard to non-evaluation of MMR that 'Delay in addressing the issue would have an adverse impact on combat employability of LCA'.

Thus, indigenous development of MMR for LCA could not be accomplished even after 22 years. Further, pending testing of MMR with the newly developed Radome, the performance testing and integration of MMR would remain incomplete, which would impact the combat employability of LCA.

iv. Multi-Functional Display System (MFDS)

Multi-Functional Display System (MFDS) facilitates display of information to the pilot relating to various functions of the aircraft. MFDS was identified in MoU (June 2002) for productionisation in Korwa Division with Transfer of Technology (TOT) from M/s Thales, France. However, the TOT did not include the core element, i.e., Optical Display Device - Active Matrix Color Liquid Crystal Display (AMLCD). As such, HAL approved (March 2006) formation of a Joint Venture Company (JVC) with M/s Samtel HAL Display Systems Limited (SHDS), New Delhi with the main objective to design, develop and manufacture various types of display systems. However, since the development of MFDs was getting delayed, HAL imported (from September 2010 to December 2012) MFDS at a total cost of ₹9.69 crore for the 20 SP (IOC) aircraft from M/s Elbit, Israel.

> Due to delay in development of MFDS by SHDS, LCA will be fitted with imported MFDS till the indigenous MFDS are realised.

In response to an audit observation (October 2014) regarding delay in development of MFDS for LCA, HAL stated (November 2014) that the HAL Board had approved (January 2008) placement of an order on SHDS for development and supply of MFD prototypes for LCA and Intermediate Jet Trainer (IJT) on successful development and certification of MFDs for Su-30 MKI.

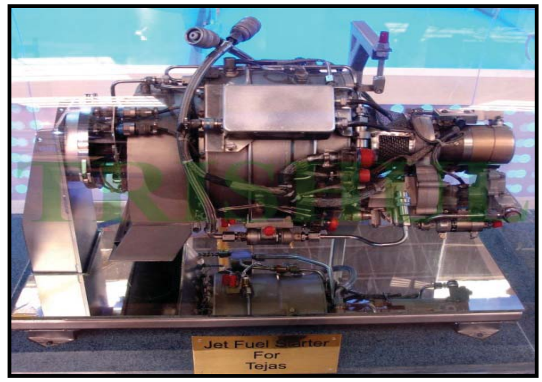
Fact remains that HAL was unable to manufacture MFDs either in-house or through the JV Company formed for the specific purpose of developing MFDs and had to resort to procurement from foreign source.

v. Jet Fuel Starter (JFS)

JFS is used to start the engine. Its performance becomes very critical particularly while operating in the Himalayan Terrain, where the temperature goes below (–) 16 degrees centigrade. As per the ASR, the LCA power plant and intake should permit at least two consecutive starts.

JFS developed by HAL for LCA is having performance issues and the modified JFS is yet to be developed and flight tested

ADA approached (November 1984) M/s HAL Engine Design Bureau (HAL-EDB), Bangalore for development of JFS (Model GTSU 110) for LCA. HAL-EDB developed and delivered to ADA[8] the first unit of JFS in February 1994 and 12 units from August 2002 onwards for PV series aircraft at a total cost of ₹25.81 crore. JFS (GTSU-110) developed by HAL-EDB had two consecutive starts capability.



We observed from the records of ADA that IAF expressed[9] the need for three consecutive starts capability of JFS against its own approved ASR. This was necessitated to cater for two main engine starts and dry rollover in-between. Accordingly, ADA sanctioned (September 2011) modification of JFS by HAL ETBRDC[10] at a cost of ₹1.99 crore. Modified JFS (GTSU 110 M1) could not be proved for the mandatory three consecutive starts in the high altitude trials and in cold weather trials held in January 2013 and January 2014 respectively at Leh. During the trials held (January 2014) at Bangalore, excessive oil consumption by JFS beyond permitted levels was noticed.

When rectification of the snag of excess oil consumption of JFS was enquired in audit (May 2014), ADA stated (June 2014) that another proposal for modification to JFS (GTSU 110 M2) had been mooted (2014) to overcome the issue of excessive oil consumption. It also stated that the first two Series Production (SP) aircraft would, however, be delivered only with the original JFS (GTSU 110) and the modification kits would be retrofitted during March/April 2015.

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8 For testing at engine test bed.

9 Copy of IAF letter and details as to when IAF expressed are not furnished to Audit by ADA.

10 Engine Test Bed Research and Development Centre – HAL EDB was later renamed as HAL ETBRDC.

Thus, development of JFS as required by IAF with three consecutive starts was still pending (January 2015) and even after the induction of LCA into IAF, the aircraft would continue to operate under concessions in respect of the JFS until it is retrofitted with modified JFS.

vi. Flight Control System Actuators

LCA is equipped with quadruplex digital Fly-By-Wire Flight Control System[11]. The maneuverability of the LCA is controlled by 13 Flight Control System Actuators[12]. ADA, in order to combat the US sanctions, had taken up (May 1998) the task of indigenizing the flight control system actuators for LCA. A committee was set up (May 1998) with participation of Control system experts from DRDO, ISRO, HAL and ADA.

Due to delay in development of flight control system actuators by VSSC, LCA will be dependent on imported actuators till the indigenous actuators are realised

Vikram Sarabai Space Research Centre (VSSC), Thiruvananthapuram was assigned (September 1998) the task of developing some of the flight critical components of the actuators viz., Elevon and Rudder actuators under the name 'Development and Advanced Linear Actuators (DALIA)'. VSSC was to pass on the Intellectual Property Rights (IPR) to the Nodal Agency, HAL for productionisation. A consortium consisting of HAL, MTAR Hyderabad, Godrej Mumbai was formed (May 2006) for productionisation of the actuators at HAL. Subsequently, HAL Board approved (November 2007) establishment of assembly and test facilities at HAL Accessories division, Lucknow for manufacture of the Actuators.

DALIA was to transfer the IPR to consortium in three phases for manufacture of 13 sets of actuators. Accordingly, HAL placed a Purchase Order (August 2009) on the consortium for manufacture, assembly and testing of the actuators at a cost of ₹14 crore after a delay of 21 months. The activities, timeframe and achievement against the delivery schedule as per the purchase order are tabulated below:

[11] Fly-by-wire control systems allow aircraft computers to perform tasks without pilot input. Gyroscopes fitted with sensors are mounted in an aircraft to sense movement changes and send signals to the computer, which automatically moves control actuators to stabilize the aircraft.

[12] (4 Elevon actuators, 1 Rudder actuator, 6 Leading edge slat Actuators & 2 air-brake Actuators).

Phase	Activity	Time frame (To = August 2009)	Revised Time frame	Actual
I (2.5 sets)	DALIA to take up assembly and testing activity. The consortium members along with HAL, Lucknow will participate in assembly and testing activity and absorb the technology.	To+21 months i.e. May 2011	To + 10 months i.e. June 2010	Expected to be supplied by December 2014.
II (2.5 sets)	Fabrication assembly and testing to be carried out under the guidance of DALIA team with the participation of HAL, Lucknow.	To+30 months i.e. Feb 2012	To + 16 months i.e. December 2010	Not completed
III (8 sets)	The entire activity from procurement of material to supply of flight worthy actuators to ADA was to be carried out. As a parallel activity, HAL, Lucknow was to establish minimum test facility at their factory which would help in conducting the sub-assembly and testing activity to support the future LCA squadron requirement.	To+36 months i.e. Aug 2012	To + 20 months i.e. April 2011	Not completed

Audit observed (September 2014) from the records of HAL that it continued to procure the Actuators from foreign source[13] due to the delay in indigenous development of the actuators. HAL replied (September 2014) that the development work and the qualification tests were completed in January 2014 and the first stage of supply of actuators would be completed by December 2014.

Thus, till the indigenously developed flight worthy actuators are delivered to HAL by DALIA, LCA will depend on imported source for these items.

To sum up, even though GoI had emphasized (June 1993) on increasing the indigenous content of LCA while sanctioning FSED in phased manner, there was no roadmap for indigenization during LCA development. ADA could not achieve indigenisation as planned in June 1993. As a result, indigenous content of LCA estimated by ADA as 70 *per cent* actually amounted to about 35 *per cent* (January 2015), with the aircraft dependent on foreign sources for important components such as aero engine, Multi-Mode Radar, Radome, Flight control System Actuators and Multi-Functional Display System.

[13] M/s BAe Systems, USA.